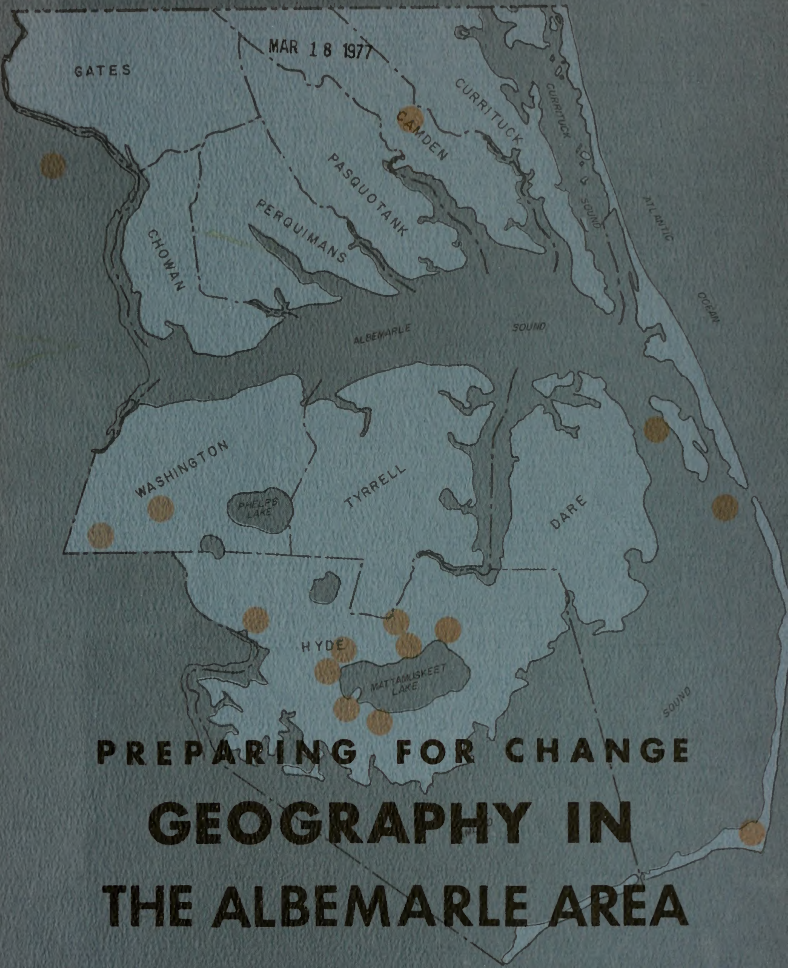
North Carolina State Library
Raleigh

N. C.
Doc

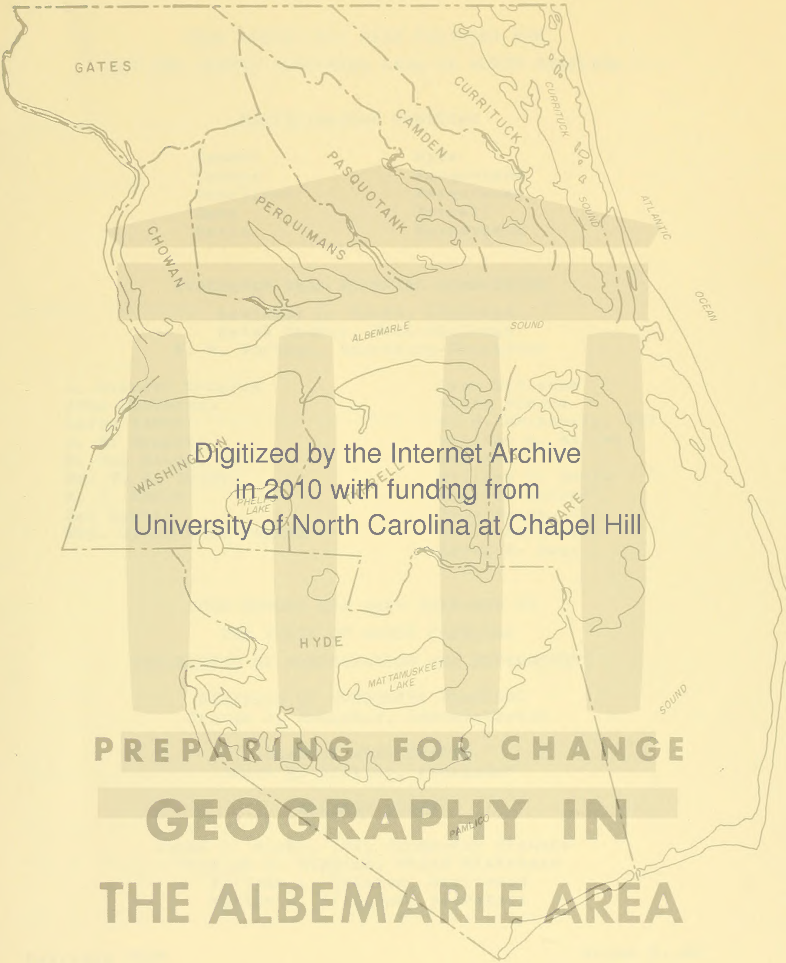
C4
11:A33/5

MAR 18 1977



PREPARING FOR CHANGE

GEOGRAPHY IN THE ALBEMARLE AREA



Digitized by the Internet Archive
in 2010 with funding from
University of North Carolina at Chapel Hill

http://www.archive.org/details/preparingforchan02nort

THIS REPORT HAS BEEN PREPARED FOR
THE TEN COUNTY ALBEMARLE AREA OF NORTH CAROLINA

PARTICIPATING COUNTIES

Camden
Chowan
Currituck
Dare
Gates
Hyde
Pasquotank
Perquimans
Tyrrell
Washington

ALBEMARLE AREA PLANNING COMMISSION

Lawrence L. Swain, Chairman
Ralph Hunter, Vice-Chairman
W. W. Foreman, Secretary-Treasurer

J. Everett Burgess
John Mitchener
Leroy Powers
J. E. Gregory
E. Roy Clark, Jr.
Dr. T. P. Brinn
W. J. White
Dal Barber
Mrs. David Ross Inglis
Leon Ballance
Alton Elmore
W. H. Weatherly, III
William A. Miller
Jim Rea
William H. Smith
Charles Harrell
Erie Haste, Jr.
R. L. Hollowell
David R. Dear

THIS REPORT HAS BEEN PREPARED BY
THE STATE OF NORTH CAROLINA
DEPARTMENT OF CONSERVATION AND DEVELOPMENT

DIVISION OF COMMUNITY PLANNING
George J. Monaghan, Administrator

COASTAL AREA OFFICE
James R. Hinkley, Director

PROJECT STAFF

James G. Blake, III, Community Planner
Douglas L. Wiggins, Chief Draftsman
William L. Grissom, Draftsman
Marian J. Alligood, Secretary

February 1967

Price $1.00

TABLE OF CONTENTS

Page

GEOGRAPHY IN THE ALBEMARLE AREA

Geological Setting 1

Minerals 5

NATURAL RESOURCES

Climate 10

Continental Shelf and Offshore Waters 12

The Outer Banks 12

The Sounds and Estuaries 15

MAPS

Map 1 Generalized Geologic Cross-Section from Wilson, N. C. to Cape Hatteras, N. C. 2

Map 2 Albemarle Area Geology 4

Map 3 Exploratory Oil Wells,Albemarle Area, 1945-1966 9

Map 4 Major Land and Water Areas,Albemarle Area 13

FOREWORD

The Ten County Albemarle Area contracted with the Division of Community Planning of the Department of Conservation and Development in November of 1964 for assistance in preparing a land development plan. In the course of the planning effort, it was decided that the work could be facilitated by preparing a series of background studies which would provide information for the formulation of the land development plan.

This study, Geography in the Albemarle Area, is the second in the series. Other background studies will focus on forestry, fisheries, agriculture and recreation. Already published is Preparing for Change - The Population of the Albemarle Area. The studies are very important elements in the planning process for they provide the data and analyses upon which the plan shall be based. These studies, along with the planning goals and objectives formulated by the planning commission, will largely determine the framework and content of the plan. The final report will be the general development plan which will contain a summation of the findings and recommendations of the background studies, an overview of area community facilities, and a presentation of the land development plan and the thoroughfare plan.

Members of the Albemarle Area Planning Commission, which is made up of the Executive Committee of the Albemarle Area Development Association and one appointee from each county, have devoted a great amount of time and energy toward making this planning program a success. The boards of county commissioners in the various counties have appropriated the money which has made the program possible and have contributed their interest and encouragement to it.

GEOGRAPHY IN THE ALBEMARLE AREA

Geological Setting

The Albemarle Area generally includes all the land east of the Chowan River and the Pungo River Basins. This includes approximately 3,300 square miles of land area and 2,600 square miles of water area.

The area has three slightly different topographic areas. The northwestern section, including most of Gates County, and the northeastern half of Chowan County consist of a gently rolling and well drained topography with ridges generally rising about 40 feet above the stream beds. The maximum relief is 72 feet, and no elevations exceed 78 feet above mean sea level.

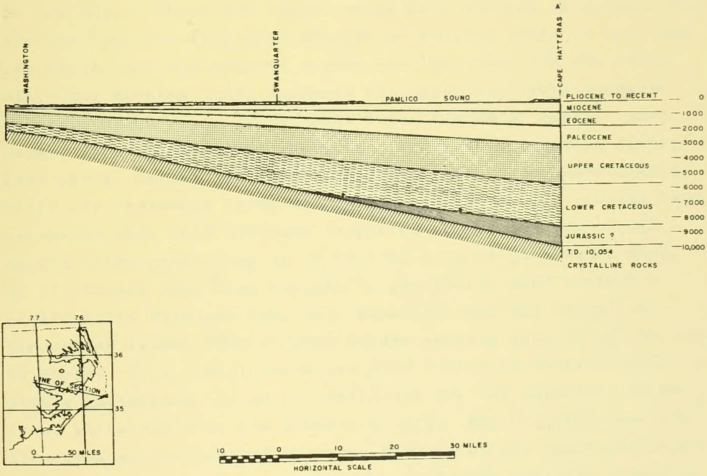
The remainder of the Albemarle Area, excluding the outer shoreline, has a topography consisting of very level, lowlying land. In part this land is swampy and lies within the so-called tidewater region. The maximum relief is approximately 25 feet, and no elevations exceed 40 feet above mean sea level. Most of the section has an elevation of less than 15 feet above mean sea level.

The third topographic area is the outer banks or shore. The outer banks of the Albemarle Area consist of approximately 130 miles of barrier sand reefs or beaches separated from the mainland by lagoons or sounds.

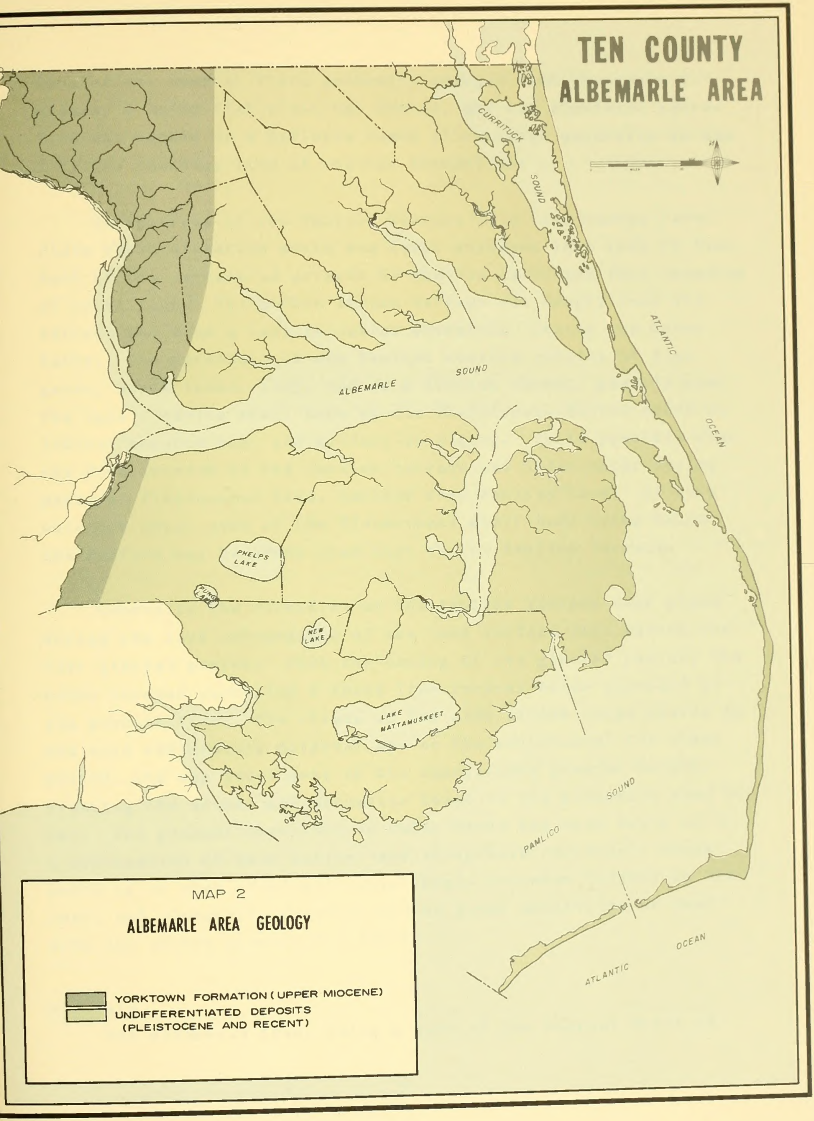
The coastal area of North Carolina is unique in that it lies midway between the emerging coastline of Florida with its sandy beaches and the submerging coastline of Northeastern United States and Canada with its deep bays and harbors. The characteristics of the outer banks resemble the shores of Florida. On the other hand, the features of the lagoons and sounds seem to be more comparable to the coastal areas of the Northeast.

MAP I

GENERALIZED GEOLOGIC CROSS-SECTION FROM WASHINGTON, N.C. TO CAPE HATTERAS, N.C.



Generally speaking, the entire Albemarle Area is underlain by sedimentary deposits which range from Jurassic to Recent in age. These sediments are commonly referred to as the Coastal Plain deposits and consist largely of unconsolidated sediments that include gravels, sands, clays, limestone and marls. The deposits of the Coastal Plain form a wedge-shaped block of sediments that increase in thickness from approximately 3,000 feet at the western edge of the area to about 10,000 feet at the Outer Banks. These sediments rest unconformably on the crystalline rocks of the Precambrian Age. See Map 1. There are seven classified sedimentary layers in this geologic cross section of which the top two are the most important to the Albemarle Area. This is because these two sedimentary formations contain all the possible mineral and water resources of any known consequence to the area. These two layers range from Miocene to Recent. The Miocene deposits span from 250,000 to 450,000 years in age, and the Recent and Pleistocene layers are less than 250,000 years old. The Miocene layer contains the upper and lower Yorktown aquifers which are a potentially major source of water. This layer, with its Yorktown formation from several feet to ninety feet thick, is the location of the deposits of phosphatic sand, which are presently being mined in Beaufort County. It has been estimated that this Yorktown formation covers an area of 450 square miles consisting of 33 billion tons of phosphatic sand. It is thought that this deposit of phosphatic sand extends a considerable distance into the Albemarle Area but Recent and Pleistocene layers form an over burden ranging from 45 to 250 feet in depth. Thus, until there are some technical breakthroughs in mining operations, it may be difficult and too expensive to extract phosphate from the Albemarle Area. Map 2 illustrates the locations of the exposed Yorktown formation, and the Pleistocene and Recent layer. The Pleistocene and Recent layer is commonly referred to as the Pamlico Terrace. This terrace is the last of seven major terraces of the Coastal Plain. Each of these terraces was formed by the ocean during intervals of submergence. As the



TEN COUNTY ALBEMARLE AREA

MAP 2

ALBEMARLE AREA GEOLOGY

land of the Coastal Plain gradually emerged from the ocean in stages, a broad flat plain was formed, and the abandoned shoreline was marked by a definite scarp illustrated generally on Map 2 by the boundary line of the two formations.

The surface of the Pamlico Terrace is a low, nearly level plain whose elevation above sea level averages less than 15 feet. Much of the terrace is covered by shallow lakes and vast expanses of swamp land. The sunken stream valleys cut deeply into the terrace and form a very irregular shoreline inside the Outer Banks. The materials of the Pamlico consist chiefly of fine sands, sandy loams, clay, and to a limited extent, gravels near the base. Marine shell beds of the Pleistocene Period occur in limited amounts near the surface at places. It is possible that the area covered by the Pamlico Terrace was under water during parts of Pleistocene time, earlier than Pamlico time. If this were the case, some of the Pleistocene shell beds lying below the surface may be older than that of the Pamlico Terrace.

Generally the formation of the Pamlico Terrace took place during the last submergence of the land surface just before the last glacial period. With the coming of the glacial period, the ocean receded producing a shore line several miles eastward of the present line. The rivers of the area eroded large basins in the soft sedimentary material and as the continental ice sheet melted, the sea level rose to its approximate present height, creating the sounds and estuaries found in the Albemarle Area today. The present shoreline or Outer Banks has been built up by a combination of wave action and alongshore currents - waves pounding on what originally were shoals situated further to the east, and alongshore currents moving great quantities of sand from its source area to the north.

Minerals

The Albemarle Area, being a part of the Coastal Plain of

North Carolina, is an area dominated by sedimentary deposits of the Pliestocene Period. These deposits are known to contain mineral resources such as shell limestone, marls, sands, gravels ilmenite (titanium), clays, peat, phosphate and greensands. It is the only region of the state which has possibilities for the occurrence of oil or gas in commercial quantities. The Albemarle Area has known deposits of the above minerals but the only deposit being utilized at the present time is sand being mined for paving purposes in Chowan, Dare, Gates, Pasquotank and Washington Counties. The latter is the largest producer.

Perhaps the most well known mineral deposit in the Coastal Plain Section of North Carolina is phosphate. This is considered the State's most important not fully developed mineral resource. Although the presence of phosphate in the Coastal Plain has been known for years, commercial deposits were not found until the year 1962. The Texas Gulf Sulphur Company has discovered deposits rich in phosphate that are fairly simple to mine because of the light overburden in Beaufort County which borders the Albemarle Area on the western side. At the present time, Texas Gulf plans to spend approximately 70 million dollars in facilities for mining and processing phosphate. Upon completion of the facilities in 1966, the initial rate of phosphate production will be three million tons per year. This extracted mineral will be mostly phosphate ore with some phosphoric acid. The very important element, phosphate, will not be produced for several years, if at all, because of the cost of electrical power needed for its production. All electrical power would have to be transmitted to the area because the construction of a power generating plant is not feasible at the present time. The minerals contained in the water supply in the area render the operation of boilers very expensive because of mineral build-up which takes place on the interior of the boilers, causing them to become inoperative without frequent periodic cleaning. Generally the phosphate industry will have very little effect upon the Albemarle Region

until the production of elemental phosphate. At that time, the Albemarle area may obtain numerous types of industries which would utilize phosphate, since the main routes of rail transportation to Megalopolis pass through the Albemarle Area.

The Industrial Extension Service at North Carolina State University at Raleigh has published several articles concerning the industrial uses of phosphate and the potentials of its use in Eastern North Carolina. Further discussion of this aspect of the potential development of the Albemarle Area will take place in the Land Development Plan.*

Another well known deposit in the Albemarle Area is titanium. Titanium is not a rare element as it is the ninth most abundant in the earth's crust. However, ilmenite, as found in the Albemarle Area, is one of the most important sources of commercial titanium. Approximately 99 percent of all titanium is used in making pigments and special high temperature steel. In recent years, the demand for titanium has been met by other deposits throughout the United States, and none has been produced in North Carolina. It is possible that deposits of ilmenite found in the Albemarle Sound and in Chowan and Perquimans Counties may someday be mined and that this mineral too may become a very important resource. For years geologists have said that commercial phosphate did not exist in North Carolina but now there is a very profitable and extensive supply being mined.

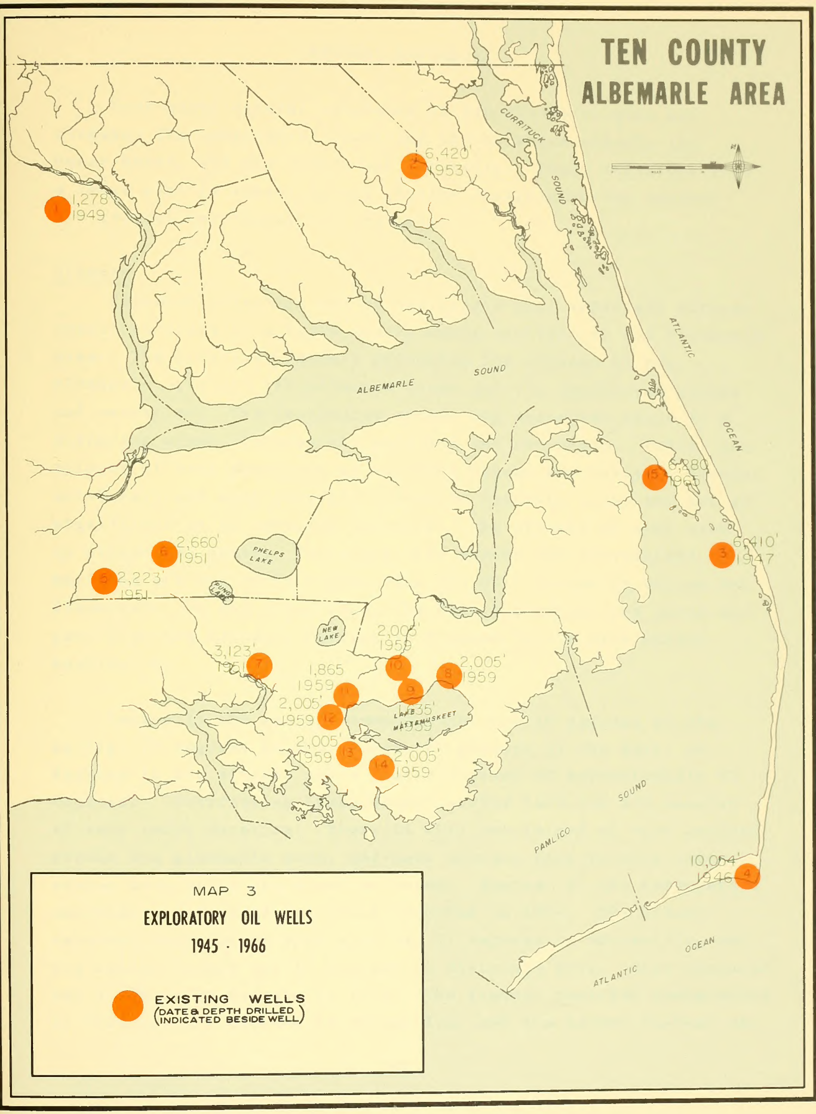
Peat is another possible commercial natural resource. Peat is a fuel and fertilizer formed by organic decaying matter. In the Albemarle Area, there are many swamps and lagoons in which considerable amounts of peat occur. One of the largest deposits

---

*The Land Development Plan for the Albemarle Area will follow this publication.

is in the Dismal Swamp of Perquimans, Pasquotank, Camden, and Currituck Counties. In the immediate vicinity of Elizabeth City, there is a deposit of good-grade peat averaging from 14 to 18 feet thick. Up until the present time no one has attempted to mine this peat commercially, but it offers an opportunity for the development of a highly specialized fertilizer industry. The fertilizer would probably be confined to the garden and florist types rather than the commercial farm types.

Another possible natural resource is petroleum and its by products. The Albemarle Area, as well as the rest of the Coastal Plain, has long been considered a particularly favorable area for the occurrence of oil or gas in commercial quantities. It is the only area in the States which contains the geologic conditions which offer possibilities for the accumulation of oil and gas. The earliest recorded exploration for oil in the State was in 1911 when the East Coast Drilling Company drilled three holes about 3.5 miles northwest of Coinjock in Currituck County. The deepest of these three wells was approximately 855 feet and no sign of oil or gas was reported. Since that time, approximately 40 wells have been drilled throughout the Coastal Plain with approximately 16 of them located within the Albemarle Area. Unfortunately no oil or gas has been found in any of them. The State leases the bottoms of sounds, rivers, and creeks and other waters to various oil companies from time to time in order to obtain information on the structure of the formations penetrated. The oil companies continue to drill for oil because of the geologic similarity to the Gulf Coast. If oil were discovered in the Albemarle Area, it would be very valuable because of its nearness to large urban populations. See Map 3 for the location of exploratory oil wells drilled in the Albemarle Area since 1945.



TEN COUNTY
ALBEMARLE AREA

MAP 3

EXPLORATORY OIL WELLS
1945 · 1966

● EXISTING WELLS (DATE & DEPTH DRILLED INDICATED BESIDE WELL)

NATURAL RESOURCES

Four major natural resources of the Albemarle Area are climate, the continental shelf and its offshore waters, the Outer Banks, and the sounds and estuaries. These resources play a large part in enhancing and ofttime restricting the economy and general development of the area.

Climate

Climate is perhaps one of the area's most important natural resources since it affects nearly every activity in the Albemarle Area. The principal factors affecting the climate of the Albemarle Area are the Atlantic Ocean and its landlocked sounds and estuaries. The freshwater sounds and estuaries serve as a buffering agent between the mainland and the ocean. Hence, the effects of such phenomena as the Gulf Stream and Labrador Current which pass and meet just off the North Carolina coast are not as significant as is commonly believed. The effects of each seem to offset the other. Therefore, the warmth and subtropical maritime air one would expect from the Gulf Stream is not as influential. On the other hand, the cold bitterness one would expect from the Labrador Current is subdued by the warm waters meeting it.

Generally the average temperatures run 60 degrees in the spring, 77 degrees in the summer, 63 degrees in the fall, 44 degrees in the winter, and a yearly average of approximately 62 degrees. Subfreezing temperatures arrive late and are usually of very short duration. There is only one record of zero weather within the Albemarle Area, and most winters pass without temperatures much below the freezing point. Typical of the temperature extremes experienced are those recorded in 1964. The lowest recorded temperature that year was 11 degrees in Gatesville, and the second lowest was 17 degrees in Elizabeth City. Cape Hatteras had a low of 25 degrees in 1964. The highest recorded temperature in 1964 was 101 degrees in Gatesville, and the second highest was

98 degrees in Elizabeth City. Cape Hatteras had a high of 92 degrees the same year.

Probably the most noticeable influences of the ocean are the seasonal changes created by it. For instance, the fall and winter seasonal effects come a little later than normally found to be the case inland. Conversely, the spring and summer come earlier than they do inland. In addition, the climate in the Albemarle region is tempered to a great extent. As given in the above, one can realize that the temperature extremes, highs and lows, are not as frequent and as severe. Thus, it is obvious that the ocean and sound areas have a definite influence on the Albemarle Area's weather where comparisons are made with other parts of North Carolina and the United States. Just as the state can be divided into topographical regions, Coastal Plain, Piedmont, and Mountain, its climate can be separated into two categories, Humid Subtropical and Humid Continental.

The average relative humidity for the Albemarle Area is slightly higher than the state's average of 71 percent. The average rainfall is approximately 55 inches, and seasonal variations are very favorable to agriculture. Yet, rainfall is sufficiently distributed throughout the year to maintain good stream flows for water supply. The lighter rains occur during the fall harvesting months, whereas the highest frequency rates and greatest monthly totals come in July and August, often as afternoon thunderstorms.

Snowfall is generally light, one to five inches, and during some years it is absent in the area. The heaviest snowfall recorded was 26 inches in 1948 at Elizabeth City. Sudden snow melts are relatively unimportant with regard to spring floods.

Storms accompanied by high wind velocities are of critical importance not only in their direct tidal effects but also with

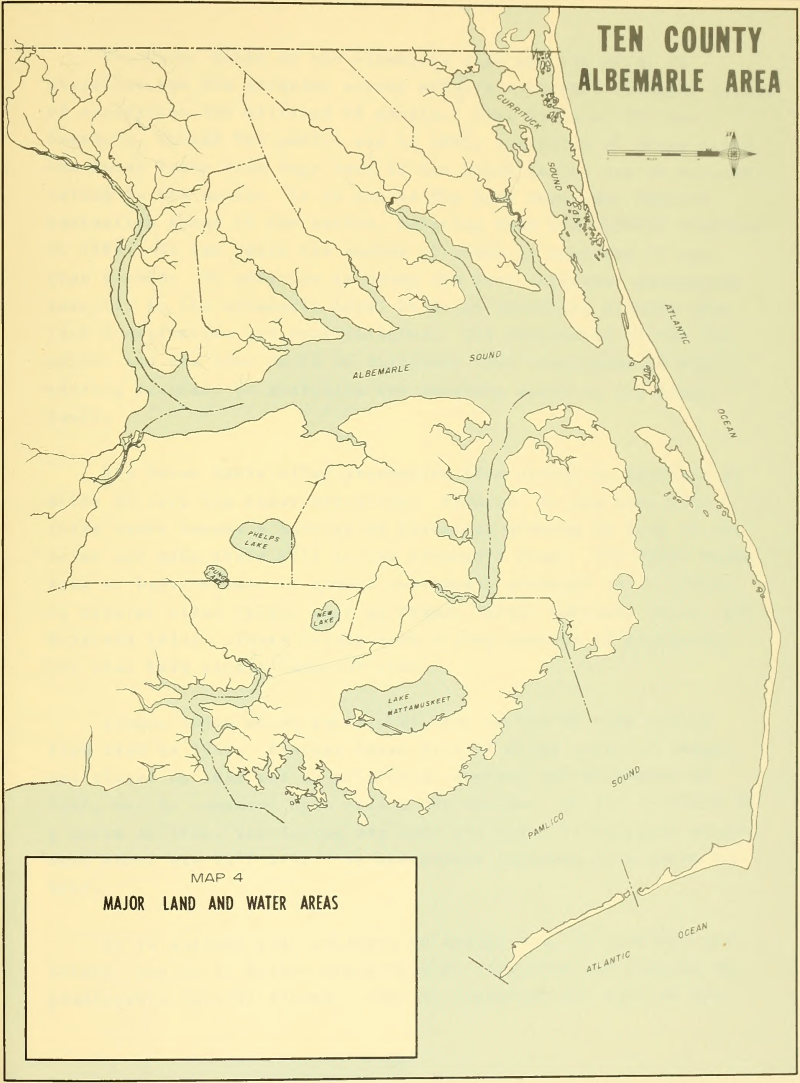
respect to the stability of shorelines, channels, etc. The prevailing wind is from the southwest. Occasionally, tropical storms of hurricane intensity subject the barrier reef or outer banks, as well as the intra-coastal areas, to very heavy rains and dangerous winds. The highest recorded wind velocity occurred during the September, 1944 storm when northeast winds reached intensities of 110 miles per hour for short intervals.

Continental Shelf & Offshore Waters

The ocean depths, temperatures, and currents immediately off the coast of the Albemarle Area have considerable influence upon one of the region's principal industries - its fisheries. The true edge of the continental shelf marks the end of a gradually sloping shelf from the coast to about the 100 fathom line where it drops off rather abruptly to the deep ocean basin. This shelf extends out from the coast at Cape Hatteras for about 21 miles. Its edge runs north at a distance of about 78 miles from Virginia and south at a distance of about 64 miles from South Carolina. The shelf provides the fisherman of the Albemarle Region with a fishing area of comparatively shallow water which is said to contain not only the most abundant but the largest variety of fish in the world. The presence of the cold Labrador Current from the north and the warm Gulf Stream from the south brings the northern food fish as well as the southern species within easy reach of the Albemarle Area's fishermen (both commercial and sports).

The Outer Banks

Perhaps no other single factor has, or will have, more influence upon the social and economic development of the Albemarle Area than the land and water conformations of the Outer Banks area. Although successive subsidence and uplift of this maritime region, during recent geological time, have been largely responsible for interior shorelines, the Outer Banks or barrier reefs have given permanence and character to the protected water expanses and their marginal areas. See Map 4.



MAP 4

MAJOR LAND AND WATER AREAS

The Outer Banks of the Albemarle with its 130 miles of shoreline and the interior sounds offer a virtually untapped source of recreation for millions of people. Cape Hatteras National Seashore, opened for public use in 1961, stretches 80 miles along the Outer Banks from Nags Head in the north to the tip of Ocracoke Island in the south. It is one of the most important federal recreation areas in the nation, counting over one million visitors in 1965. In ten years the number of users is expected to more than double. In addition to being the most important recreation facility in the Albemarle Area, it is an important venture into land preservation and stabilization. The Department of the Interior and the Army Corps of Engineers have cooperated in implementing programs to stabilize the shifting sands on the Outer Banks.

The Outer Banks offer protection from storms to hundreds of miles of very low inner-shoreline. However, at the same time, these banks become a barrier to fishermen wishing to fish in the ocean and make their port in the Albemarle Area. The Outer Banks Area or barrier reef is almost continuous although it is broken by several tidal inlets such as Oregon Inlet, Hatteras Inlet, and Ocracoke Inlet. These inlets have a long history of migration, but they have always remained open.

Oregon Inlet moved some 7,000 feet in the 66 year period from 1850 to 1916. Another inlet just 10 miles south of Oregon was closed in 1922 and an artificial opening was attempted in 1924, but it remained open only a few months. It was reopened by a storm in 1932, but during the next few years it migrated southward about one half mile. It was closed entirely by a storm in 1947.

It is evident that attempts to dredge new, or maintain old inlets, may be in direct opposition to intensive and usually unpredictable natural forces. This is certainly the case of the

Oregon Inlet. Several attempts have been made to deepen and widen this inlet in an effort to provide a stable channel for fishing craft in order that they could transverse the banks from the ocean to a safe harbor in one of the sounds or estuaries. These efforts have been in vain since the storms of January and February of each year play havoc with the channel. Up to the present, no attempts have been made to stabilize Oregon Inlet by constructing jetties or applying other methods of stabilization.

The barrier reef itself is frequently breached by severe storms, although it may be from a few hundred feet to several miles wide. This breaching by the ocean has left the land itself very unstable since the reef is composed principally of sand with dunes in some cases averaging from ten to twenty-five feet in height. During historic times, this reef and its dunes were once well wooded or grassed over but they are now generally denuded and exposed to the mercy of the weather. When the first colonists settled in North Carolina, the Outer Banks was heavily forested with pines and large hardwoods. Early inhabitants felled the trees for lumber to build their boats and houses. As time went by, the indiscriminate harvesting of trees continued, and no new trees were planted. Open range grazing by horses, cattle, and hogs eliminated seedlings and permitted the wind and tides to drift sand to and fro on the banks. In recent years various measures, such as sand fences and native grass planting, have been tried to increase the stability of the sand and thus stop the shifting of the dunes. These measures have had considerable success in the Kitty Hawk Memorial area, but it will take several years to fully evaluate the success in other areas.

The Sounds and Estuaries

Shorelines, composed of sandy barrier beaches with narrow lagoons immediately landward thereof, are relatively common. However, the occurrence of broad sounds behind these barries, or Outer Banks, as encountered along the coast of the Albemarle Area

is exceptional. The Currituck, Pamlico, Croatan, and Roanoke Sounds were all formed by the emergent outer shoreline. Unlike the others, the Albemarle Sound was formed by the drowned stream valley of the Roanoke River. See Map 4.

In times past, these expansive protected waterways formed the backbone of the transportation system. The population of the area was water oriented, using the waterways not only for transportation but also for commercial fishing and recreation. When highway and railway transportation became more important in the latter part of the nineteenth century, water transportation declined. The vast wetlands, the sounds, and the wide rivers became barriers to land travel and thus separated much of the region from the rest of the state. Fishing and subsistence farming became a way of life for many people living in the more isolated parts of the region.

Beginning at the northern section of the region, Currituck Sound has an area of about 160 square miles, including Back Bay, which is an arm extending beyond the Virginia boundary. This sound is about 40 miles long, three to four miles wide, and less than seven feet deep over most of the area except within manmade channels. The nearest ocean connection is Oregon Inlet, approximately 24 miles below the southern mouth of the sound. Consequently, it is essentially a fresh water body draining the bordering swamps and lowlands of Currituck County. It is considered to be an excellent fresh water game fishing area.

Albemarle Sound, the sunken valley of the Roanoke River, evidently once flowed to the sea past the present location of Nags Head. The barrier beach or reef along this section of the coast was built up by the ocean during a later period to form Roanoke and Currituck Sounds. Albemarle Sound has a surface area of over 500 square miles. It extends some 55 miles in an east-west direction, averaging about seven miles wide, and with fairly

uniform depths of 17 to 20 feet. Its large drainage area of over 10,000 square miles, including the Roanoke, Chowan, Perquimans, Little, Pasquotank, North and Alligator Rivers, plus the Currituck Sound watersheds and its indirect ocean connections, give Albemarle Sound fresh water characteristics favorable to shad, herring, and rock fish migration and spawning.

Croatan Sound and the more recently enclosed Roanoke Sound are separated by Roanoke Island to form parallel connecting channels from the Albemarle Sound to the northern end of the Pamlico Sound and the adjacent Oregon Inlet. Croatan and Roanoke Sounds are relatively small in area - about 35 and 25 square miles, respectively. Although of equal length, eight miles, Croatan Sound is both wider, two to four miles, and deeper, seven to ten feet, than Roanoke Sound which ranges from one-half to two miles in width and one to three feet in depth. Consequently greater flows through the former and higher salinities in the latter affect their relative suitability for migratory fish and oyster production. The Croatan Sound is a favorite fishing area, and the Roanoke Sound is better suited for oysters.

Pamlico Sound, with over 1700 square miles of surface area, is by far the largest of the sounds, and it constitutes a major portion of the southern end of the Albemarle Area. It extends some 70 miles in its longest northeast-southwest dimension and varies from 10 to 30 miles in width. Outside of its extensive shoal areas, this sound has a fairly uniform depth of about 20 feet. The shoals occur along the entire shoreline, merging in the bordering marshes. Shoals have also been formed at the four existing inlets to the sound from the ocean and between the converging mouths of the Neuse and Pamlico Rivers. Bluff Shoals, which extends northward from Ocracoke Island, has been formed by the merging waters of the Albemarle and the Pamlico Sounds. The salinity of Pamlico Sound waters varies greatly with time and location thus materially affecting the prevalence and distribution of its many marine life species.

Pamlico Sound and its estuaries are very important to the region as this is where most of the shellfish are harvested. Shrimp are plentiful even though the catch has declined in recent years. Oysters are increasing in number, and the outlook for oyster production is excellent. The salinity of the sound is such that oyster growth is excellent, yet the main natural enemy of the oyster, the starfish, cannot survive because of the freshness of the water.

The striking importance of the Pamlico estuaries can better be realized by examining the catch record of seafood and the reason these drowned stream valleys are so productive. The oyster catch has been declining for years, but in 1964 Hyde County's catch increased, indicating a reversal of past trends through the efforts of state and private interests in reseeding and cultivating oysters. The estuaries of Dare County are said to be the most productive in the state because of accompanying tidal marshlands. Coastal marshlands are one of the major features of the estuary system. It has been proven in recent years that the salt marsh areas are essential breeding grounds in the life cycle of many marine species. The relatively calm, saline backwaters, supplied with nutrients by the rotting organic matter in the marshlands, form productive mediums for marine life. The nutrients, which normally would be washed out to sea, ebb and flow among the organisms. In this manner food is provided for creatures ranging from one-cell animals to clams, snails, oysters, shrimp, crabs, and fish. Oysters are found living their entire life in estuaries, and shrimp require estuarial conditions during the first few months of existence. Research by Dr. Eugene P. Odum of the University of Georgia, has yielded conclusive evidence that estuaries are among the most naturally fertile areas in the world, producing vast amounts of food for animals and man assistance from expensive cultivation.

The productivity of brackish estuarine waters was estimated as nearly twice that of the world's best agricultural lands, approximately seven times greater than that of continental shelf waters and 20 times greater than open ocean waters. Thus, the tidal marshlands, which provide most of the fertility of the estuaries, are certainly not worthless as was once thought. In fact, the marshlands are a very important natural resource and must be protected if they are to continue to function as nature intended.

STATE LIBRARY OF NORTH CAROLINA
3 3091 00747 5882